Hello everybody, happy test week! Study hard, and check out last week’s resource if you would like extra practice with topics/concepts or practice problems. This week marks the beginning of second unit material for all sections, so please get ahead and check out this awesome information about inheritance!

Remember: the Tutoring Center offers free individual and group tutoring for this Genetics. Our Group Tutoring sessions will be Tuesdays from 5:15-6:15 PM at the Sid Rich basement, room 75! You can reserve a spot at https://baylor.edu/tutoring. I hope to see you there!

Keywords: Pedigree, Testcross, Linked Genes, Recombination, Gene Map

**Topic of the Week: Linked Genes and Recombination (7.1-7.2)**

Linked Genes: genes which do not follow mendel’s second law of inheritance (in that they do not segregate independently of one another) because the cross over together

Genes at different Loci May follow one of may patterns

- **Completely Independent**: genes at two loci always assort independently
  
  *note: generally, these are genes on separate chromosomes

- **Incompletely Linked**: genes at two loci that have a great deal of physical separation on the same chromosome; normally assort independently, but other times are linked

- **Completely Linked**: genes at two loci on a single chromosome that will be linked at any crossover event

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Additional sources are the property of The National Basketball Association, McGraw Hill Biology, and NBC Universal.
**Crossing Over**: exchange of material between adjacent arms on homologous chromosomes in **prophase I** of gamete formation

**(a) No crossing over**

1. Homologous chromosomes pair in prophase I.
2. If no crossing over takes place...
3. ...all resulting chromosomes in gametes have original allele combinations and are nonrecombinant.

**(b) Crossing over**

1. A crossover may take place in prophase I.
2. In this case, half of the resulting gametes will have unchanged chromosomes (nonrecombinants)...
3. ...and half will have recombinant chromosomes.

**Recombination**: the formation of novel allelic combinations not present in the parents

**Recombination Frequency** \((f_R)\): \[
\frac{\text{number of recombinant progeny}}{\text{total progeny}} \times 100\%
\]

\(f_R\) represents the likelihood that crossing over produces recombinant offspring at two **incompletely linked** loci.

The **recombination frequency** between two **completely linked** loci would be 50% if a crossover event happened in every meiosis. This is because at a single crossover, **half** of the gametes will be **recombinant** and the **other half** will be **non-recombinant**.

**Frequency of recombinant gametes**: the likelihood of the creation of each gamete, which will be \(\frac{1}{2}\) the \(f_R\).

**Simplification**: frequency of recombinant gametes = \(\frac{1}{2} f_R\)

**Testcross**: an individual with hetero- or homozygous dominant expression of a gene is crossed with an individual who is recessive at both loci.

*Generally we use a double heterozygote crossed with a homozygous recessive*

What is the expected genotypic ratio of a \(AaBb\) x \(aabb\) cross?

1:1:1:1

If genes are **linked**, the number will deviate from this.

**Terminology:**

**Wild-Type**: the allele most commonly seen in nature

**Mutant-Type**: a new allele created by natural or laboratory mechanisms which exists with a wild type allele at a locus (although many examples categorize these as recessive, they can be dominant or recessive, depending on the inheritance pattern of the wild type allele)

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**Gene Configuration:** the conformation of homologous chromosomes with respect to where the how the dominant and recessive alleles are aligned at each locus

**Coupling (cis):** both dominant and both recessive alleles are present (at their respective locus) on each homolog \( \frac{A}{a} \frac{B}{b} \)

**Repulsion (trans):** 1 dominant and one recessive allele on each homolog \( \frac{A}{a} \frac{b}{B} \)

*Yes, this is the same as the conformations of vinyl H-atoms in double bond stereochemistry!

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**Highlight #1: Pedigree Analysis (6.2)**

[https://www.youtube.com/watch?v=Gd09V2AkZv4](https://www.youtube.com/watch?v=Gd09V2AkZv4)

**Symbols used in pedigrees:**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaffected person</td>
<td>No condition, sex unspecified</td>
</tr>
<tr>
<td>Person affected with trait</td>
<td>Sex unspecified</td>
</tr>
<tr>
<td>Obligate carrier (carries the gene but does not have the trait)</td>
<td>Sex unspecified</td>
</tr>
<tr>
<td>Asymptomatic carrier (unaffected at this time but may later exhibit trait)</td>
<td>Sex unspecified</td>
</tr>
<tr>
<td>Multiple persons (♂)</td>
<td>Male (♂)</td>
</tr>
<tr>
<td>Deceased person</td>
<td>Sex unspecified</td>
</tr>
<tr>
<td>Proband (first affected family member coming to attention of geneticist)</td>
<td>Sex unspecified</td>
</tr>
</tbody>
</table>

**Autosomal Recessive:** Equal proportions in males and females; can **skip** generations/be ‘hidden’ by carriers *(note: obligate carrier symbol will not always be shown in a pedigree)*

**Consanguinity:** inbreeding/cross between cousins

**Autosomal Dominant:** Every affected individual must have an affected parent; **Won’t skip** generations

**X-Linked Recessive:** Unequal proportion of males and females affected (more in males); may **skip** generations

**Rule of Thumb:**

When a daughter is affected, the father is affected
An affected son’s mother has the trait, or is a carrier (heterozygote)

**X-Linked Dominant:** Every affected individual must have an affected parent; **Won’t skip** generations

**Rule of Thumb:**

Every affected male’s daughter has the trait
Sons: inherit from mom **only**
Daughters: inherit from mother or father

**Y-Linked trait:** Passed from father to son; doesn’t skip generations (**males only**)

*Note: see table 6.1 for more conditions for each of these general rules of thumb*
Week 4 Concept Check:

1. What pattern of inheritance is displayed by the pedigree?
2. True/False Two alleles, A^o and A^p have a recombination frequency of 43 so they are in separate linkage groups
3. Two loci, A(a) and B(b) are located near each other on a chromosome. A female in \textit{cis} configuration is heterozygous at both loci and crosses with a recessive male. What is the recombination frequency of the following linked gene?

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\frac{AB}{ab})</td>
<td>82</td>
</tr>
<tr>
<td>(\frac{ab}{ab})</td>
<td>78</td>
</tr>
<tr>
<td>(\frac{Ab}{ab})</td>
<td>8</td>
</tr>
<tr>
<td>(\frac{aB}{ab})</td>
<td>4</td>
</tr>
</tbody>
</table>

\textbf{THINGS YOU MAY STRUGGLE WITH:}

1. If you are stuck between multiple possible types of inheritance on a pedigree, try drawing out the crosses; sometimes, several inheritance patterns may \textit{seem} identical, but they will have differences that can be visualized by a cross. When doing this, work from homozygous recessive individuals because you automatically know their genotype.
2. In a testcross evaluating recombination frequency, the recombinant progeny will be those which exist in the smallest numbers.

3. If the recombination frequency between two genes is \( \geq 50 \), the two are treated as two separate linkage groups, or on separate chromosomes, because they assort independently.

**You Try:** Click the link to try these practice problems on google forms!

**Formative Practice Week 3:**
[https://docs.google.com/forms/d/e/1FAIpQLSe7uszVJmMFnA4nSn_9eK7R7g7sNtuzOa24BrlirF7ENZN-eO/viewform?usp=sf_link](https://docs.google.com/forms/d/e/1FAIpQLSe7uszVJmMFnA4nSn_9eK7R7g7sNtuzOa24BrlirF7ENZN-eO/viewform?usp=sf_link)

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**CONGRATS:** You made it to the end of the resource! Again, group tutoring will be every Tuesday from 5:15-6:30 PM. You can reserve a spot at [https://baylor.edu/tutoring](https://baylor.edu/tutoring). I hope to see you there!

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Answers:
1. X-Linked Dominant
2. False
3. \( f^2 = 0.0698 \)

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